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CONCERNING TRAUMATIC PARALYSES OF THE OCULAR MUSCLES, WITH CASES.[1]

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DURING the last few years a number of important papers on traumatic paralyses of the ocular muscles have appeared. Those by O. Purtscher, H. Friedenwald,[2] Paul Simon,[3] Gustav Ahlström,[4] and Panas[5] may be especially mentioned.

Evidently a paralysis of any one of the ocular muscles may be caused by direct division within the orbit of the muscle, its tendon or its nerve, by fracture of the orbital wall or apex, and by an extravasation of blood in, or an inflammation of, the orbital contents. Such palsies in general terms are classified as orbital and peripheral paralyses.

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[1] Read before the Section of Ophthalmology of the College of Physicians of Philadelphia, October 16, 1900.

[2] "Traumatic Paralysis of the Abducens Nerve." Archives of Ophthalmology, Vol. XXIII, 1894, pp. 361 and 403.

[3] "Ueber traumatische Nuklearlähmung der Augenmuskeln." Beiträge zur Augenheilkunde, Bd. 3, 1898, p. 31.

[4] "Zur Kasuistik der traumatischen Augenmuskellähmungen." Beiträge zur Augenheilkunde, Bd. 4, 1889, p. 21.

[5] "Paralysies oculaires motrices d'origine traumatique." Archives d'Ophtalmologie, No 10, 1899, p. 40.

On the other hand, the seat of the paralyzing lesion may be intracranial—that is, basal or cerebral, the last including the nuclear, fascicular and cortical palsies.

Not only may the paralysis be primary, but it may develop secondarily from basal meningitis, hæmorrhage, abscess, or nuclear degeneration, and may appear days and even months after the injury. Finally, a certain number of traumatic palsies must be attributed to operative interference—that is to say, to division of the ocular muscles during operation upon the orbit. To give an idea of the relative frequency of the paralyses of the various muscles of traumatic origin, the table which has been compiled by Ahlström, who has analyzed one hundred and twelve cases from the literature and added nine of his own, may be quoted:

Paralysis of the external rectus (abducens)	73
Paralysis of the superior oblique	7
Total ophthalmoplegia	6
Total oculo-motor (third nerve) paralysis	6
Paralysis of the inferior rectus	5
Paralysis of the superior rectus	5
Paralysis of the internal rectus	4
Total oculo-motor (third nerve) paralysis plus paralysis of the external rectus	4
Paralysis of the inferior oblique	3
Paralysis of the external rectus plus paralysis of the superior oblique	2
Total oculo-motor (third nerve) paralysis plus paralysis of the superior oblique	2
Paralysis of the external rectus plus the inferior rectus	1
Paralysis of the inferior rectus plus the internal rectus	1
Paralysis of the internal rectus plus the superior oblique	1
Paralysis of the superior rectus plus the inferior oblique	1

From this table palsies due to direct trauma of the nerve, tendon or muscle, as it lies in the orbit, are omitted. It is evident that the external rectus is much more frequently affected than any of the other muscles.

The following cases, which I desire to add to the literature of this subject, are invested with certain interesting clinical features.

Case I. *Paralysis of the Left Inferior Rectus from a Knife-thrust; Advancement of the Severed Tendon with Tenotomy of the Superior Rectus; Cure.* — C. H. W., 35 years of age, colored, came to the Jefferson College Hospital on May 28, 1896, stating that thirteen days previously he was engaged in a fight and received the following injuries: One wound 7.5 cm. long on the vertex of the skull, another 4 cm. in length over the parietal eminence, and a third beginning about 8 mm. from the corneal margin and passing slightly downwards and backwards. The lips of this wound were pouting and from it was springing a mass of granulations such as one sometimes sees after a tenotomy. The vision of each eye was normal and the ophthalmoscopic examination negative.

The movements of the right eye were normal in all respects; those of the left eye complete except the downward rotation, which was practically wanting. With a red-glass the classical symptoms of paralysis of the left inferior rectus were developed.

Under cocaine anæsthesia the granulation tissue was removed and the tendon, severed from its attachment on the sclera, was found in a mass of soft tissue. It was reattached to the sclera, being advanced several millimeters. Diplopia still persisting, the superior rectus was divided, when single vision was obtained when the eyes were in the primary position. Healing followed without incident and the patient was dismissed from the hospital in a few days. He appeared once or twice afterwards, but has since been lost sight of.

I have seen two other cases in which I believe the tendon of the ocular muscle was separated from its scleral attachment by an injury, the one in the eye of a young man, who while running, tripped and fell, striking his eye against the point of a fence paling which was tipped with iron. Not only was there complete failure in the downward rotation of the eye, but there were other injuries to the deeper structures. The patient, however, was not in my charge, and I was able to make only one examination and know nothing of his subsequent history. I assume from the position of the wound near the insertion of the inferior rectus that this injury may have explained the palsy.

In the other case the external rectus of the left eye of a young man was torn from the attachment by the sharp horn of a cow. This patient was also not under my care, although I was present when the apparently detached muscle was secured by another surgeon, very much as was the inferior rectus in the case which I have detailed.

Case II. *Division of the Pulley of the Superior Oblique During an Operation for the Relief of Abscess of the Orbit Caused by Suppurating Ethmoiditis; Spontaneous Disappearance of the Diplopia, with Restoration of the Normal Rotations of the Eye.*—This case has been reported in some detail,[1] and I will refer to it very briefly. The patient suffered from a large abscess of the orbit due to purulent ethmoiditis. When I made an incision through the brow from the inner to the outer angle in order to open the orbit, I found the inner two-thirds of the superior orbital margin and a portion of the roof of the orbit denuded of periosteum, a carious process having already begun in the orbital margin. The pulley of the superior oblique was recognized and found loosely adherent to a fragment of carious bone which was detached. The patient entirely recovered from the operation, and was discharged from the hospital six weeks later. Diplopia, which was typical of that caused by paralysis of the superior oblique—all the classical symptoms of this palsy being present, slowly disappeared. When the patient was presented to the County Medical Society more than a year after the operation, it was difficult to develop diplopia even with the aid of a red-glass. The lid and eye possessed normal movements; in fact, the function of the eye in all respects was natural. It is now more than four years since the operation, and no one could possibly tell that the function of the superior oblique had ever been interfered with.

Case III. *Injury of the Superior oblique and Superior Rectus During an Operation for the Removal of a Tumor from the Orbit; Crossed Vertical Diplopia in the Upper Field of Fixation; Homonymous Vertical Diplopia in the Lower Field.*—A girl, 13 years of age, presented herself during the early portion of this year in the Jefferson College Hospital with a tumor of the right orbit. After a prolonged medicinal treatment without amelioration my colleague, Dr. H. F. Hansell, very successfully removed the growth, which proved to be tuberculous. He has fully reported the case before the Ophthalmic Section of the American Medical Association at its meeting in Atlantic City during last June. The wound healed promptly, although there was moderate ptosis which improved but never entirely disappeared.

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[1] Medical and Surgical Reporter, November 20, 1897.

Gradually there was a return of the growth, and a hard mass reappeared in the upper and outer portion of the orbit, and on June 15th of the present year I again opened the orbit through the line of the former incision and found a tumor, which I removed, together with the lachrymal gland which was more or less involved in the process. All of the tissues were much tied down by inflammatory adhesions and it was not possible to recognize individually the orbital structures. The growth proved, like the previous one, to be of tubercular nature. Its more detailed description is reserved for another communication.

The recovery was uninterrupted; the ptosis remained as before, but diplopia now appeared under the following conditions: In the primary position with the lid raised there was binocular single vision but in the upper field there was crossed vertical diplopia, the false image being projected upward and to the left. When the test-light was depressed into the lower field of fixation homonymous diplopia appeared, the false image being projected to the right and downward. Diplopia did not appear until the test-object was raised 15° above the horizontal plane, nor until it was lowered 5° below this position and turned to the left 10° and to the right 25°. This condition of affairs was practically unchanged when the patient was last examined during September of the present year, although the double images were less troublesome and chiefly noted when going up and down stairs.

Of these three cases perhaps the most interesting is the first one, in which it would seem that there is little doubt that the tendon of the left inferior rectus was divided by a knife-thrust, although I can not state positively that it was entirely severed from the scleral attachment, as, for example, it would have been by a tenotomy. Certainly the tendon as

I found it was displaced from its point of normal insertion and the injury appeared to be a direct one. This is especially interesting because Panas has stated in his elaborate paper that detachment of the insertion of the tendon from the sclerotic as a cause of muscular paralysis by direct traumatism to the muscle remains to be proved, at least for the generality of cases. This would seem one in which that proof was pretty positive.

The interest which attaches to Case II, where I know that I detached the pulley of the superior oblique, resides in the restoration of binocular single vision, or, as I have expressed it, in the spontaneous disappearance of the diplopia. Exactly how this is to be explained is difficult to say, unless we assume that in the inflammatory products, which afterwards cicatrized, the tendon formed a new insertion or attachment and again exerted its normal influence upon the rotations of the globe.

The third case is interesting because doubtless the tendons of the superior rectus and superior oblique were more or less involved in the inflammatory processes which had succeeded the first operation and either were detached in part or entirely, or else were injured in such a way that their function was disturbed. With the knowledge of the preceding case I am inclined to think that there will be again a spontaneous restoration of the normal ocular rotations. The slight ptosis which is present is really of advantage to the patient in preventing diplopia.

Case IV. *Paresis of the Right Inferior Rectus Following a Fall Upon the Right Side of the Head; Recovery.*— An unmarried man, 25 years of age, presented himself for treatment on account of blurred vision and diplopia. He gave the following history: General and family history good; eyes always strong and used without discomfort; two weeks before his visit, during a storm at sea, he was thrown into the scuppers of the boat, striking upon the right side of his head and face. Save for a few bruises on his cheek and forehead and a sharp nose bleed, apparently he had suffered no hurt from his fall. Three days later, however, he began to be annoyed with indistinct vision and at times diplopia. This continued, the latter symptom increasing until he sought advice, two weeks after the accident.

The vision of the right eye was $^{15}/_{\text{xx}}$, the amplitude of accommodation 8 D., the cornea slightly astigmatic, the pupil reactions normal, the fundus free from disease. The vision of the left eye was $^{15}/_{\text{xv}}$, the amplitude of accommodation 9.5 D., no astigmatism, pupillary reactions and fundus normal.

There was crossed diplopia, chiefly in the lower field, the images being one above the other, with a slight inclination of the lower image to the right. There was manifest upward strabismus of the right eye, the lower pupillary margin being about 3 mm. higher than that in the fellow eye; in other words, the ordinary signs of paresis of the inferior rectus were present. When the eyes were rotated downward there was slight lagging of the right behind the left, but no ultimate failure in the excursion.

At first the images were fused by a three-degree prism, base down, before the right eye. Within a few days, however, this fusion was possible only with an eight-degree prism, and still later it took between nine and ten degrees of prism to create single vision.

There was absolutely no sign of fracture about the orbit nor any symptom that could prove fracture elsewhere in the cranium. The patient had been and was annoyed only by the diplopia, particularly in his occupation as a clerk.

On general principles, and partly with the hope that some effusion, probably hæmorrhagic, might be stimulated to absorption, ascending doses of iodide of potassium were ordered. He never, however, took more than thirteen grains three times a day, and soon, on account of digestive and other disturbances, reduced this dose to five grains three times a day.

At the end of two months there was still diplopia, although the patient had become used to it. It was readily relieved by a five-degree prism. Six months later 3.5 degree prism at twenty feet and five-degree prism at the reading distance were required to bring about single vision. The patient was not seen for nearly five months, at which time he returned stating that he had no inconvenience from his former muscular troubles, although careful tests with prisms still showed, when full action of the inferior rectus was required, a paresis of two degrees. The upward deviation of the right eye noted in the earlier portion of his trouble had disappeared. The patient has been seen many times since this date, now fully six years ago, and although he has not submitted to accurate ocular examination, there is no ordinary sign of orbital muscle palsy.

CASE V. *Paralysis of the Left Superior Rectus and Left Levator Palpebræ Following a Fall Upon the Left Side of the Head and Forehead; Tenotomy of the Left Inferior Rectus; Complete Recovery.*—A married woman, about 26 years of age, on the Fourth of July, 1891, was thrown from a buggy striking the left side of her head and left supra-orbital region, probably against a stone in the road. The immediate result of the accident was extensive ecchymosis of the injured region, swelling of the eyelid, unconsciousness, and for a number of days all the symptoms of severe concussion of the brain.

After these symptoms had subsided the following ocular conditions were present: Partial left ptosis, the upper lid covering the pupil, from which position it could not be elevated; slight downward strabismus of the left eye and crossed diplopia with superimposed images in all portions of the field, the images being fused with the eyes in the primary position by a prism of fifteen degrees, base up, before the left eye.

Both discs were hazy, the veiling of the margins of the left optic disc being quite marked. The vision of the right eye was normal, that of the left $^{20}/_{\text{XL}}$.

There was no paresis of accommodation. One month later the ptosis was slightly better, the edge of the upper lid being on a level with the upper margin of the pupil. The degree of superior rectus palsy was unchanged, in the primary position fifteen degrees of prism being required to fuse the images, above the horizontal level twenty-two degrees.

At the end of two months, during which time the patient was treated with iodide of potassium, later with strychnia and at intervals with electricity, the ptosis entirely disappeared, the action of the levator being apparently perfectly restored. There was no change, however, in the degree of the superior rectus palsy.

Two more months of similar treatment produced no effect and therefore the tendon of the left inferior rectus was divided, laceration of the capsule being avoided. The immediate effect of this tenotomy was an overcorrection of three degrees. Three weeks later double vision was absent in all portions of the field of fixation except in the extreme lower field.

Vision was now normal in each eye and the accommodative power 9 D. The veiling of the edges of the optic disc had also disappeared. The refraction proved to be a low simple astigmatism and a glass was given correcting this anomaly, to which was added a three-degree prism, base down, to correct the tendency to diplopia in the lower field—the remnant of the overcorrection. This diplopia persisted for three months, at the end of which time it was not possible to obtain double images in any portion of the field of fixation, and with the Maddox rod there was practically orthophoria at twenty feet, actually an esophoria of two degrees. Prismatic glasses had long been discontinued and the patient no longer complained of any double vision unless her general condition was below par, when sometimes there would be transient diplopia. She has been seen many times since the date of the last examination recorded, and the ocular conditions are normal.

CASE VI. *Traumatic Paresis of the Right Superior Oblique Following a Fall on the Right Supraorbital Region; Later Paresis of Accommodation; Recovery.*—A boy, healthy in all respects, $10^{1}/_{2}$ years of age, in the first week of January, 1896, while skating fell striking heavily upon his forehead over the right eye. He was somewhat dazed, but not unconscious, complaining for a time of nausea. A few days later it was found that he was unable to read with any degree of comfort and he complained of pain in the forehead and in the eyes. When he was examined, two weeks after the accident, vision in each eye was $^{6}/_{v}$. The amplitude of accommodation was 14 D., the pupil reactions were normal, each optic disc was congested, and the retinæ were markedly streaked in the neighborhood of the papillæ.

With eyes in the primary position there was homonymous diplopia, the images being one above the other, that of the right or affected eye being lower than its fellow and inclined to the sound side. The lateral separation was obliterated by a prism varying from two to four degrees, while the vertical separation did not appear to be much more than one degree. The youth of the patient rendered it difficult to study the relation of the double images to each other with accuracy.

The patient was placed upon small doses of iodide of potassium and returned for examination in three weeks vision, as before, being $^{6}/_{\mathrm{V}}$ in each eye. The lateral separation of the images was now two degrees, the vertical separation about one-half degree. He no longer complained of diplopia and the nausea and pain had disappeared.

He was not seen for four months, when he returned, no longer complaining of diplopia, which had long since entirely disappeared, but stating that his vision was markedly blurred and that he could not see to read. The vision of the right eye was now about $^{6}/_{\mathrm{XXX}}$ and the left $^{6}/_{\mathrm{IX}}$. A + .75 D. before the right eye brought the vision back to $^{6}/_{\mathrm{V}}$, and with a + 4.50 D. added to this lens, J. 1 could be read from five to seventeen centimeters. The left eye accepted no glass for the distant point, and without a glass the near point was 12.5 cm., or in other words, the accommodative power was 8 D. The congested condition of both discs and retina remained unchanged.

Strychnia was ordered and in two weeks the vision of the right eye was $^{6}/_{\mathrm{XV}}$ without a glass, of the left $^{6}/_{\mathrm{V}}$. The right eye had partly regained its accommodative power; the left eye was practically normal so far as this function was concerned. At the end of another month vision was $^{6}/_{\mathrm{VI}}$ in each eye and the accommodative power 10 D. in each, not quite so great as it had been at his original visit when the near point had been 7 cm. There was no diplopia and no deviation of the eyes in any way, even the Maddox rod failing to show a faulty tending of the visual lines. After complete atropinization the refractive error was found to be +.75 D. in each eye. There was no corneal astigmatism.

Since using these glasses the slight asthenopia of which he complained has disappeared.

Case VII. *Paresis of the Left Inferior Rectus Following a Fall on the Head, Succeeded by Concussion of the Brain; Recovery.*—An unmarried man, 22 years of age, in good health, and with no history of ocular trouble, came on October 14, 1896, to obtain relief from diplopia. He gave the following history: Three weeks before he was thrown from his horse and fell in a field of plowed earth striking heavily upon his head; where exactly was the chief impact of the blow he did not know. There were no external wounds. He was picked up unconscious and remained so for three days. His attending physician, Dr. Radcliffe Cheston, writes that during this period there was severe concussion of the brain, that shock was very marked, and that for a week the pulse was slow and feeble.

On regaining consciousness he noted the double vision. Examination gave the following results: Vision in each eye $^6/_{\text{VI}}$, normal ophthalmoscopic appearances, amplitude of accommodation 7 D. in each eye. The pupil reactions were normal. There was crossed diplopia in the lower field, or at least, chiefly noted in the lower field, but not entirely absent even in the upper field. In this lower field the images were one above the other, that of the left or affected eye being lower than its fellow and inclined to the sound side. Apparently the image appeared to stand behind the other. The separation of the images, when the test object was moved from the lower field, was greater than when on the horizontal level or above the horizontal level. If the test object was extended sufficiently far into the upper field of fixation, the images were fused. Their vertical separation was annulled by a prism of six degrees and the lateral separation by a prism of three degrees.

In all respects the study of the double images corresponded to a paresis of the left inferior rectus, with the single exception that the inclination of the false image was to the sound and not to the affected side, which might perhaps be accounted for by a coexisting esophoria. The difficulty of distinguishing between a superior oblique palsy and an inferior rectus palsy under these circumstances is well known.

The treatment consisted of small doses of iodide of sodium, which was continued for two weeks, at the end of which time diplopia had almost disappeared.

Case VIII. *Paralysis of the Left Superior Oblique Following a Fall on the Head Succeeded by Severe Concussion of the Brain; Recovery.*—A married man, about 60 years of age, in good health, fell from a trolley car and struck upon his head and point of his shoulder. The fall took place not far from his own house, to which after lying on the track in a dazed condition, he managed to make his way. When examined by his physician, Dr. Eckfeldt, and later by Dr. De Forest Willard, he was found to have all the symptoms of severe concussion of the brain and some symptoms which indicated fracture, namely, hæmorrhage from the left ear, although Dr. Willard in his account says that the evidences of fracture were uncertain.

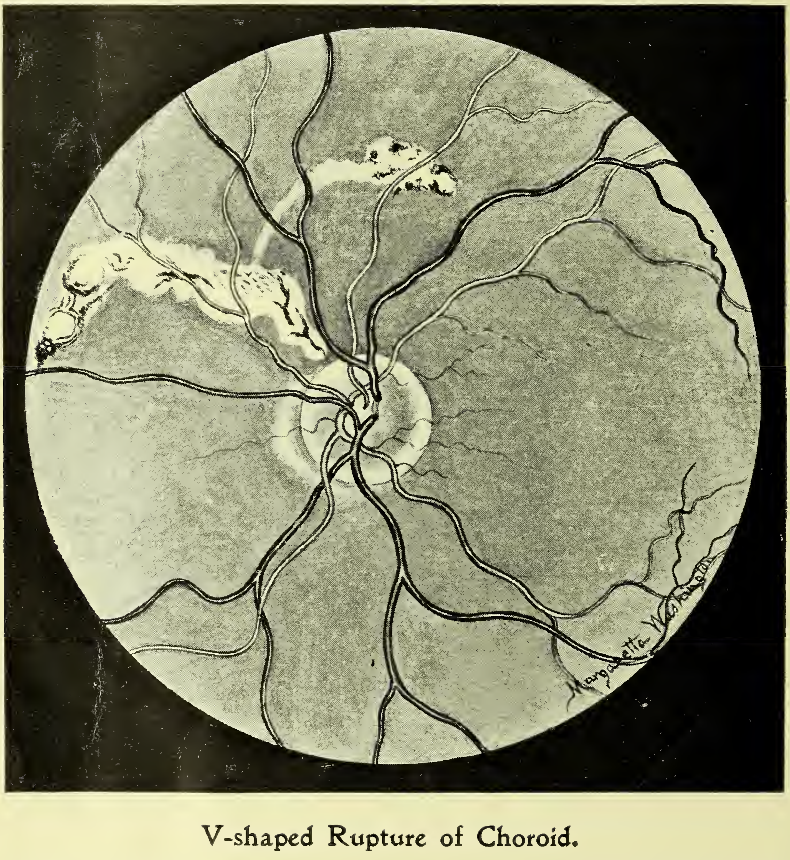
Sixteen days later when I examined him, and his intellect was perfectly clear, he was complaining of diplopia, which had been present from the very start, or as soon as he had sufficiently collected his senses to observe the disturbance of vision. With the usual tests there was homonymous diplopia, chiefly in the lower field, the image of the left or affected eye being lower than its fellow and inclined to the sound side. Movement of the test-object downward and to the left increased the obliquity of the images. The vertical separation was neutralized by an eight degree prism and the lateral by a four degree prism. He was placed upon ascending doses of iodide of sodium and took also strychnia. One month later there was decided improvement, although the symptoms of left superior oblique paresis were still present. The lateral separation of the images was now two degrees and the vertical separation six degrees. Recently this patient was again examined and the ocular movements are entirely normal and the eyes natural in all respects.

Fortunately, recovery was complete in all these five cases and, therefore, the localization of the lesion is at best a matter of speculation. All of them, I think, may be classified with the intracranial palsies. In three of them, Cases V, VII and VIII, there was severe concussion of the brain, and in one of them, Case VIII, hæmorrhage from the ear, which indicates the possibility of a fracture, although the surgeons in charge were not sure of this point. Fracture of the base can not be excluded because the classical symptoms of this disease are not present. In Roberts' famous case, quoted by Purtscher, only the slightest symptoms of cerebral concussion were present, together with paralysis of the abducens, and yet the patient died four months later, and there was found a transverse fracture through the upper third of the right temporal bone, and that the nerve had been torn at the level of this fracture. Therefore, perhaps, with the exception of Case V, these are best explained by a lesion at the base of the skull.

Case V is excluded from the basal and orbital classification because it is difficult to conceive how an injury of the nerve in either of these regions would not also have affected the ciliary muscle and iris, which were normal. A more probable explanation is a nuclear lesion, one, moreover, situated in the anterior portion of the nucleus affecting that portion which controls the levator palpebræ and the superior rectus.

It is difficult to place the lesion in Cases IV and VI, especially in the former. The patients suffered almost not at all except from the ocular muscle palsy which followed the fall, that is to say, there were no symptoms referable to the orbit or the cranium. The entire absence of orbital symptoms would probably exclude the theory that the nerve or its tendon was pressed upon by an exudation into the orbital contents. It is hard to believe that there could have been a fracture or any decided lesion at the base with so little general disturbance.

Case VI may perhaps be explained by a basal lesion, perhaps by a nuclear lesion, but like the preceding one, does not lend itself readily to interpretation. It is interesting to observe that in two of these cases the superior oblique was affected, which Purtscher remarks is probably more often injured than one would suppose, its symptoms being masked by other palsies that may be present.



V-shaped Rupture of Choroid.